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Dear Tom - I had my  
brother this assie too, and  
could get no funding from EPA.

5-3-67

5/11/49

Please label my newspaper the subject. Yours,  
Joshua Lederberg



## We're So Accustomed to Using Chlorine That We Tend to Overlook Its Toxicity

CHLORINE IS a poison-  
ous gas. Its chemical reactiv-  
ity is so high that it cannot  
long persist in nature, being  
rapidly converted to the in-  
nocuous chloride ion, the  
form in which it is most  
abundantly found as, for ex-  
ample, in common salt. It is  
an extremely important in-  
dustrial chemical playing an  
indispensable role in the  
production of plastics,  
drugs, pigments and many  
other organic materials.

In the form of sodium hy-  
pochlorite, domestic bleach  
solution, it is a well-known  
household article. It also  
plays an indispensable role  
in the purification of our  
water supplies. We are so  
accustomed to meeting it in  
our environment that we  
hardly notice it except when  
someone has zealously over-  
dosed his swimming pool.

The chlorination of water  
supplies in the United  
States began just 60 years  
ago in Jersey City. Its use  
spread very rapidly and  
today it is undoubtedly the  
major bulwark against ty-  
phoid fever, dysentery and  
cholera. It would be con-  
servative to say that it has  
saved, millions of lives. In  
fact, concentrated urban set-  
tlement would be impracti-  
cal without chlorination or  
some equivalent means of  
removing polluting bacteria  
from water.

CHLORINE HAS been  
used for the treatment of  
sewage since 1835, long be-  
fore Pasteur and Koch  
showed that infectious dis-  
ease was an attack upon the  
human body by living mi-  
crobes. The rationale was  
the dissipation of foul or-

ders, which were long  
blamed for contagion.

Chlorine was first intro-  
duced in the waterworks of  
Jersey City in response to  
potential contamination by  
sewage from some small  
towns above it. The city de-  
manded that the water com-  
pany install expensive filtra-  
tion equipment or pay for  
diversion of the sewage.  
After considerable litiga-  
tion, the court found that  
chlorination was both safe  
and effective for the produc-  
tion of potable water.

It is difficult to recon-  
struct the arguments that  
would support the safety of  
chlorination by contempo-  
rary standards. A few tests  
of acute toxicity did show  
that chlorinated water could  
be administered in concen-  
trations to 50 to 100 parts  
per million, compared with  
the 1 to 2 PPM generally re-  
quired for water purifica-  
tion. Furthermore, during  
World War I, chlorine,  
under the name of Dakin's  
solution, was the only avail-  
able disinfectant for contam-  
inated wounds, and it did a  
heroic job by the standards  
of the day.

THIS ARTICLE is not a  
scare story about a newly  
discovered hazard of an in-  
gredient to which most of us  
have been constantly ex-  
posed to since birth. It is,  
rather, a reminder that al-  
most no attention has been  
given to the subject of  
chronic toxicity from chlo-  
rine.

Perhaps we sense such a  
dependence on the chlorine  
disinfection of water that  
we prefer not to be embar-  
rassed by information about

relatively minor side effects.  
This view is not, however,  
likely to be defended as a  
rational basis for social pol-  
icy.

The only serious contribu-  
tion to the subject that I  
could find was from a Ger-  
man scientist, Dr. H. Druck-  
rey of the Max Planck Insti-  
tute for Immunobiology at  
Freiburg. He reared a group  
of laboratory rats for seven  
generations on drinking  
water supplemented with  
100 PPM of chlorine. The  
treated animals showed no  
obvious pathology or short-  
ening of the life span com-  
pared to the controls. This is  
an impressive demonstra-  
tion that should have been  
made at least 50 years ear-  
lier.

Many theoretical suspi-  
cions nevertheless remain.  
One argument for chlorine  
is its rapid removal by reac-  
tion with organic material  
in body fluids. These reac-  
tions have, however, not  
been studied with modern  
methods. We have no clear  
picture of the place, man-  
ner, intermediate products  
or rate by which chlorine is  
converted into chloride ion  
within the body. These expe-  
riments would not be very  
difficult to carry but with  
the help of radioactive tra-  
cers.

WHAT LITTLE we do  
know of the chemistry of  
chlorine reactions is porten-  
tous. It should sometimes  
react with nitrogenous  
groups from various sources  
to form substances that may  
eventually reach and react  
with the genetic material,  
DNA, of body cells. This is

only a speculation so far. In  
any case, it would probably  
be applicable only to heavily  
contaminated waters need-  
ing heavy doses of chlorine.

The reactions of chlorine  
with DNA have been re-  
markably little studied. In  
my own search in the litera-  
ture, I found only a single  
oblique reference. Chlorine,  
casually compared with io-  
dine, rapidly inactivated  
DNA that had been isolated  
from bacteria.

We know little more of  
the mechanism by which  
chlorine kills bacteria. The  
scanty data suggest that the  
most likely mechanism is  
precisely by attack on the  
DNA of the microbe.

That chlorine is also in-  
tended to inactivate viruses  
should provoke questions  
about the production of mu-  
tations in view of the close  
chemical similarity between  
viruses and genes. Many ge-  
neticists have raised cau-  
tions about chemicals that  
may cause mutations, and I  
will join them by adding  
chlorine to the lengthy list  
that cry out for close scru-  
tiny.

Science is under broad at-  
tack today for creating an  
unmanageable technology  
that swamps human individ-  
uality, fouls the environ-  
ment and imperials the sur-  
vival of the species. More  
often than not, however, sci-  
ence may be blamed for  
carrying the bad news that  
we know too little rather  
than too much to support  
the growing numbers of  
people who proliferate  
themselves and their wastes  
over the planet.

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\*when it suited them, they rediscovered (and I believe  
exaggerated)  $CHCl_3$  as a carcinogen.

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